

# The Mu2e Digitizer ReAdout Controller (DiRAC): characterization and radiation hardness

venerdì 31 maggio 2024 08:35 (1 minuto)

The Mu2e experiment at Fermilab will search for the charged-lepton flavour violating conversion of negative muons into electrons in the coulomb field of an Al nucleus, planning to reach four orders of magnitude beyond the current best limit. The conversion electron will be identified by a high-resolution Straw tracker and an ElectroMagnetic Calorimeter.

The calorimeter system is composed of 1400 crystals coupled to SiPMs, each readout by preamplifiers and custom high frequency digitizer boards (DiRAC). The calorimeter is located inside a high vacuum cryostat that hosts a superconducting magnet and to reduce the number of pass-throughs and the cable length, the front-end and the read-out electronics are also located inside the cryostat. This poses serious design issues due to this harsh environment, aggravated by the fact that the collaboration to limit costs has decided to use only COTS components. Simulation studies estimated that, in the highest irradiated regions, the front end and the digitizer boards will be exposed to a total dose of  $\sim 1.5$  krad per year of run with a heavy hadrons ( $E > 20$  MeV) fluence of  $\sim 10E9$  cm<sup>2</sup> per year. The Mu2e collaboration requires to qualify the electronics boards for 5 years of life and besides require applying to this qualification a safety factor of 12.

The DiRAC was validated for operation in high-vacuum and under 1T B-field. An extensive radiation hardness qualification campaign, carried out with photons from Co-60, 14 MeV neutron beams, and 200 MeV protons certified the DiRAC design to sustain doses up to 30 krad, neutron fluences up to 1012 n1MeV/cm<sup>2</sup> and very low numbers of single-event effects occurrences. Dedicated latchup-safe solid state fuse circuit was embedded in the design to automatically protect the board and recover from fault conditions. We provide a detailed description of the design and of the qualification campaign.

## Collaboration

## Role of Submitter

I am the presenter

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**Classifica Sessioni:** Electronics and On-Detector Processing - Poster session

**Classificazione della track:** T7 - Electronics and On-Detector Processing